Fourier space analysis in EUV reticle mapping using RESCAN: Influence of reflectivity induced diffraction asymmetry in actinic imaging.

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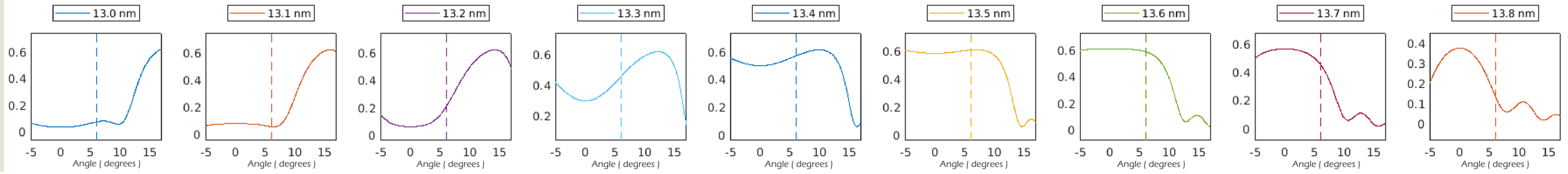
ABSTRACT

RESCAN is an actinic pattern inspection (API) platform based on scanning coherent diffraction imaging (SCDI), under development at the Paul Scherrer Institut. This research tool uses coherent illumination to record diffraction images and computationally recover high-resolution actinic maps of the EM wave, exiting the reticle, without using imaging optics. The lens-less imaging technique employed in RESCAN allows the potential of direct Fourier space analysis along with the ability to simultaneously retrieve both the reticle amplitude and phase maps, making RESCAN one of the promising solutions for APMI. In this paper, we address a hitherto neglected aspect in actinic mapping, namely Fourier spectral asymmetry induced by the non-uniform multi layer mirror reflectivity. By illuminating the reticle sample with highly monochromatic EUV photons with varying wavelengths between 13.0 and 13.8 nm, we study the effect of angle dependent reflectivity on the far field diffraction patterns and its implications in imaging. By employing CDI the complex image of the reticle is obtained. In our preliminary studies, we observe a good correlation between spectral asymmetry and the image quality. The results are supported by 1-D calculations, showing how spectral asymmetry modulates both amplitude and phase maps. We believe that these results have implications for mask metrology especially towards understanding the inherent imaging artifacts in actinic maps.

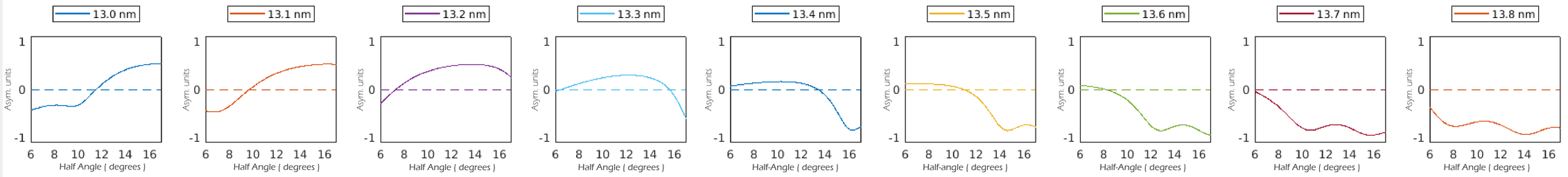
MOTIVATION

ANGLE DEPENDANT REFLECTIVITY OF MULTILAYERS.

REFLECTIVITY



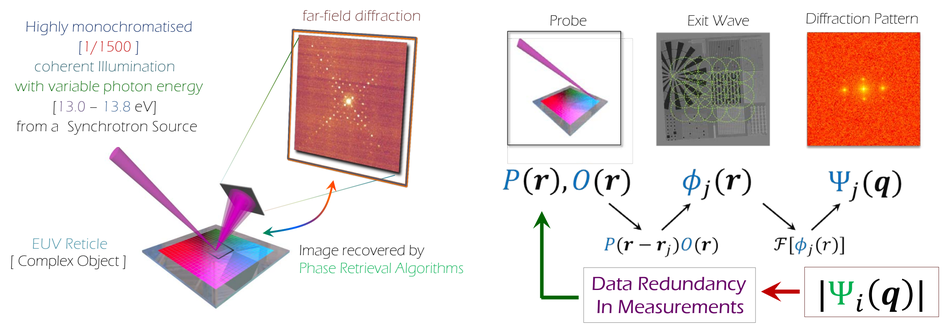
ASYMMETRY



TECHNIQUES

SCANNING COHERENT DIFFRACTION IMAGING – ACTNIC LENSLESS RETICLE IMAGING TOOL - RESCAN

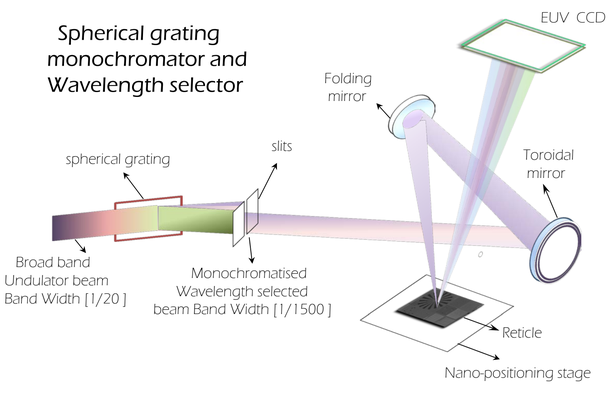
IMAGING PRINCIPLE



ADVANTAGES

- Lensless Imaging. (cost effective)
- High resolution imaging - up to 20 nm on mask. (scalable)
- Through pellicle metrology. (actinic & simple geometry.)
- Allows imaging of extended objects (beyond spot size.)
- Simultaneous retrieval of Object Amplitude & Phase (without through focus scan.)

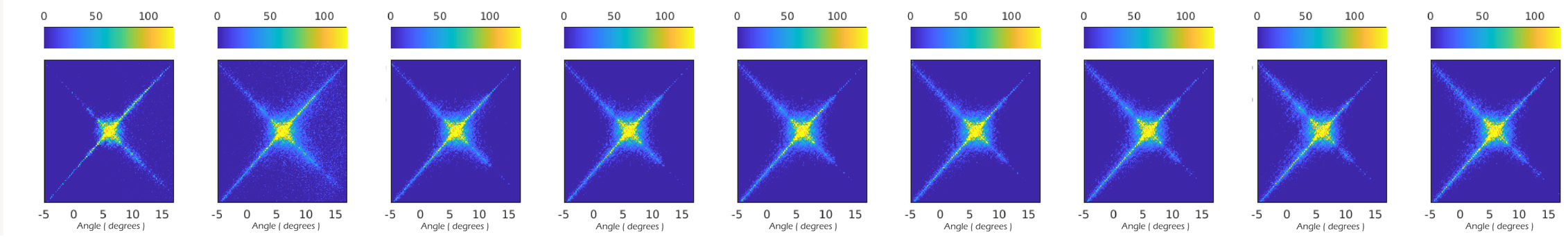
EXPERIMENTAL SETUP



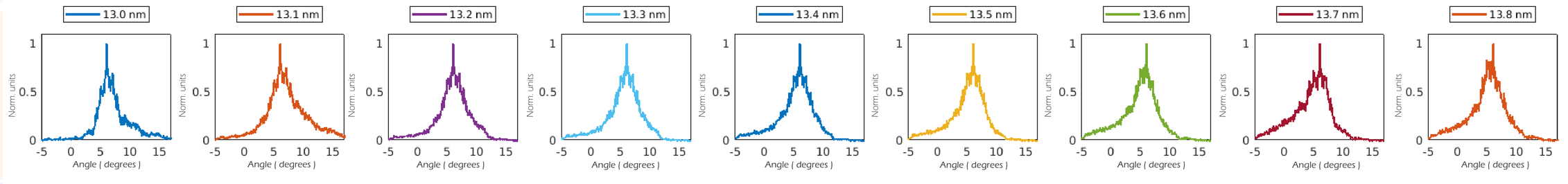
EXPERIMENTAL RESULTS

ASYMMETRIC DIFFRACTION SPECTRA OBSERVED

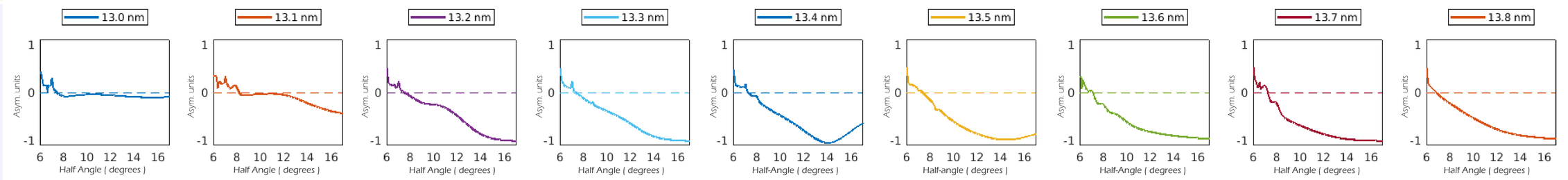
DIFFRACTION IMAGES



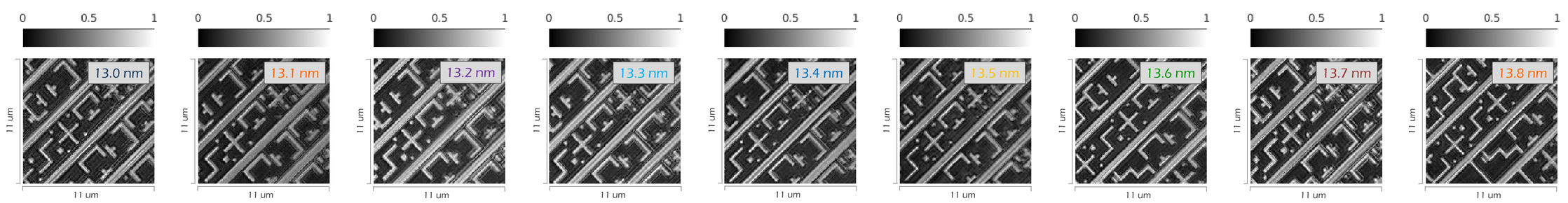
VERTICAL SUM



ASYMMETRY



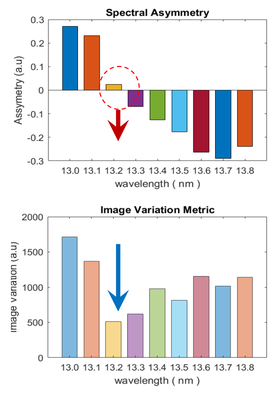
RECOV. IMAGE



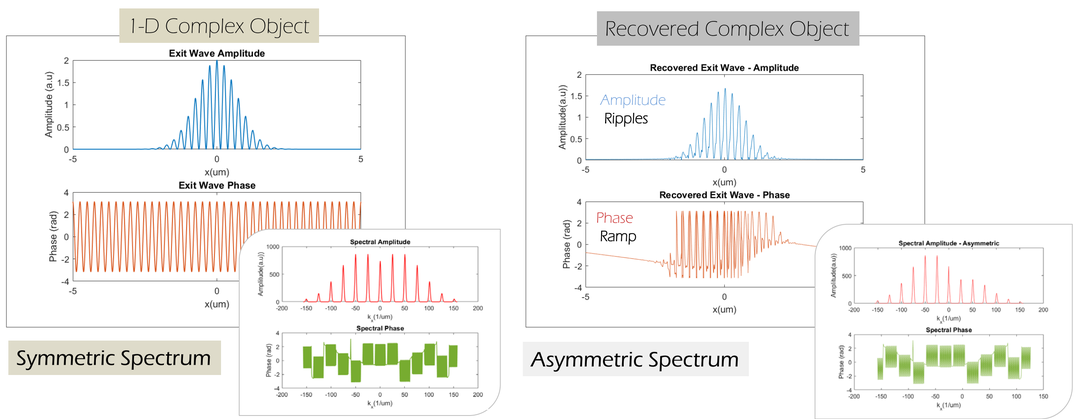
CONCLUSIONS

CORRELATION BETWEEN SPECTRAL ASYMMETRY AND IMAGE QUALITY

CORRELATIONS



I-D ANALOGY



SUMMARY

- The far field diffraction pattern from a reticle is inherently asymmetric due to reflectivity asymmetry of the multilayer.
- Asymmetric spectral distribution can lead to artifacts in aerial Imaging – Amplitude Modulations, Phase Ramps for ex.
- Wavelength Variation with highly monochromaticity illumination scheme could plausibly quantify these fundamental actinic imaging artifacts.
- Spectral domain analysis of EUV reticles using SCDI is a powerful technique for characterizing the complex reticle images.